

“Questions in Biology”
Designing an online discussion forum for promoting active learning about Evolution

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Abstract

The present context of Portuguese Higher Education, as a consequence of the so-called ‘Bologna Process’, asks for pedagogical innovations in order to promote the acquisition and development of competencies such as critical and creative thinking and problem solving, where questioning plays a central role. The design and implementation of student centered approaches, in order to enhance deep and active learning, requires an alignment between teaching strategies, learning outcomes and particularly assessment methods, which strongly influence students’ approaches to learning.

This chapter describes the process of designing and implementing a teaching-learning-assessment strategy called “Questions in Biology” in the context of a Curricular Unit taught by one Biology Professor to first year undergraduates at the University of Aveiro (Portugal), during two academic years (2007/2008 and 2008/2009). “Questions in Biology” started as an online discussion forum (ODF) hosted at the e-learning platform of the University where students had the opportunity to develop questioning, discussion and argumentation about topics in Evolution. During the second year, some ODF improvements were introduced as well as the implementation of presential group discussions during lectures.

Students’ performance was assessed along the study. Data collected by interviewing the Professor and some of the students provided evidences of the positive impact on student quality learning. Also, as a result of this strategy, the number of teacher-student and student-student interactions increased, enhancing both oral and written questioning and argumentation by students. Results show the positive influence of “Question in Biology” in attaining the

intended learning outcomes and the development of competencies by students, with the assessment playing a central role on the teaching and learning processes.

Key-words: Students' questioning, Higher Education, Evolution, assessment, active learning

1. Introduction

Communication is the basis of all teaching-learning processes where questioning is an important element for the continuous exchange of ideas, knowledge and feelings between the teacher and students, and also between the students themselves. Indeed, several studies show that the promotion of a true spirit of inquiry can improve the quality of teaching and learning in several ways (Chin and Osborne 2008).

Students' questions can be very useful for the teacher, providing important evidence on learning gains (Chin 2001; Watts, Gould and Alsop 1997; White and Gunstone 1992), generating opportunities for the identification of incorrect conceptions as well as the main obstacles for conceptual understanding. In this way, students' questions have the potential in facilitating the design of teaching strategies according to students' needs and motivations (Chin 2007, Maskill and Pedrosa de Jesus 1997, Hadzigeorgiou 1999).

Students could also benefit from the questioning processes, triggering their thinking, scaffolded, and even extended, by a particular teacher question, or perhaps a question formulated by one of their peers (Chin et al. 2002; Pedrosa-de-Jesus and Moreira 2009). King (1994), for example, states that peer questioning promotes the social construction of learning since it might raise and solve socio-cognitive conflicts. During peer-interaction different perspectives emerge and are integrated. The formulation of one student question might lead to the formulation of hypothesis, the establishment of predictions and reflections by other students.

Questions can lead to learning even when formulated by ourselves, since self-questioning might be helpful in organizing ideas and managing tasks. Indeed, from the students' perspective, the process of formulating a question requires attention on the contents and the selection of the main ideas, resulting in learning by itself (King 1994, Schmidt 1993).

The vast importance of questioning for the quality of teaching and learning processes seems to be rooted on its relation to the process of understanding itself:

'Questioning is one of the thinking processing skills which is structurally embedded in the thinking operations of critical thinking, creative thinking and problem solving. It consists of the smaller micro-thinking skills of recall, comprehension, application, analysis, synthesis and evaluation [...] Questions guide knowledge construction in the formation and changing of the cognitive networks or schemata.' (Cuccio-Shirripa and Steiner 2000, p.21).

Despite the benefits of question asking (and answering), our research work, developed in the context of higher education, has revealed that teacher-student interactions and even student-student interactions are not as frequent as it would be desirable. In fact, many lectures tend to be monologues interrupted by some teacher questions which main purpose tend to be the checking of knowledge acquisition. During the majority of the university lectures, moments of 'true' dialogue, where the teacher and students try to share meaning, tend to be rare. Dialogues initiated by a student (question) lean to be even less frequent. Generally speaking, students rarely intervene by self-incentive and often only when solicited by a teacher question. Usually, undergraduates tend to adopt a passive posture perceiving lectures as 'information reception moments' (Pedrosa-de-Jesus and Moreira 2009). According to Graesser and Person (1994), the low frequency (and low quality) of student questions can be connected to several reasons such as: difficulties in indentifying relevant information, social barriers and lack of communicative skills.

Therefore, it urges in re-thinking classroom strategies in order to promote *effective* and *active* inquiry environments, like it is intended by the recent curricular reforms in Portuguese Higher Education courses, as a consequence of the so-called “Bologna Process”. More than the carrying out of ‘new obligatory procedures’ in a ‘top-down’ policy, it aims to promote the design and implementation of student centred approaches, requiring an alignment between the teaching strategies, the learning outcomes and particularly the assessment methods (Biggs 2007, Veiga and Amaral 2009). It is well described in the literature that assessment plays a central role in learning, strongly influencing the student behaviour and the adopted study methods. Therefore, assessment should act as a tool for meaningful learning (Black and William 1998) and every learning experience should be assessed and properly adapted to each of the teaching-learning contexts (Hofstein et al. 2005).

2. “Question in Biology” – main purposes and initial design

This chapter aims at describing the process of designing and implementing a student centred strategy, called “Questions in Biology”, developed during two following academic years (2007/2008 and 2008/2009) in the context of a Curricular Unit dealing with topics of Evolution. The initial design intentions and its later adaptations due to field work experiences will be highlighted. The study aimed at supporting, motivate, inspire and ‘contaminate’ other Biology academics to ‘try’ out similar strategies, towards the promotion of the scholarly teaching (Trigwell, Martin, Benjamin and Prosser 2000).

The discipline, Themes and Laboratories in Biology (TLB), has been taught since 2006 by the same Professor, on the second semester, to approximately 70 first year undergraduates coursing Biology and Biology/Geology Education at the Aveiro University (Portugal). Students are divided in two classes, each of one having a two hour lecture per week.

The design and implementation of this strategy was planned collaboratively with the Professor and two Science Education researchers, following a co-researcher methodology (Macaro and Mutton 2002). During the entire semester the two researchers attended and observed all lectures (non-participant observation) and had regular informal meetings with the Professor to discuss future development of the teaching-learning processes of the discipline. Data was also gathered by interviewing (semi-structured interviews) the Professor at the end of the semester in order to evaluate the implementation process of the strategy. Some students' were also selected for individual and group interviews, based on their expressed interest in participating in the strategy. With the informants consent,, all interviews and observed lectures were audio-taped and verbatim transcribed in order to allow further content and discourse analysis, respectively (Tuckmann, 1999).

The intention was to design a strategy that could result in the creation of a complementary environment for the lectures, providing students more opportunities to question, argument and discuss topics in Evolution privileging a more structured way rather than the traditional 'one way' classroom oral discourse. The central focus should be on students creating meaning, confirming and sharing understanding, by means of developing an interactive community of learners addressed to high levels of thinking and meaningful learning, where questioning should play a central role. Since the discipline is only lectured once a week, in two hours sessions, it was decided to take advantages of the potentialities of the new information communication technologies, using the Online Discussion Forum (ODF), communication tool hosted at the e-learning platform of the University (Figure 1). ODFs have been used extensively and are one of the most commonly used tools, since asynchronous text-based discussion present several advantages for students: more opportunities to interact with each other, more time to reflect, to think and to search for further information before making a contribution to the discussion (De Wever, Schellens, Valcke and Van Keer 2006). There is,

indeed, some empirical evidence about computer mediated text-based communication facilitating higher-order thinking (Garrison et al., 2000, Garrison and Cleveland-Innes 2005). The design and implementation of an asynchronous online discussion plays a significant impact on the nature of interactions and influences the way students approach their learning. It is well known that the number of interactions does not reflect the quality of discourse content. Evidences of higher-order learning are usually related to the context of the learning environment and to an effective teaching presence that encourages participation and triggers discussion. The discussion should not be teacher centred. Instead, interactions should be facilitated in a sustained manner, by moderating and shaping the direction of the discourse. If deep approaches to learning are intended to be achieved, which is one of the main goals of “Questions in Biology”, then there should be a specific design goal, providing clear participation requirements and content expectations. Also, assessment should be congruent with the intend goals (Garrison and Cleveland-Innes 2005).

(Insert Figure 1 here)

Considering the importance assessment plays in learning, it was decided that all the students’ contributions would be assessed and that each student should post at least two questions/comments in order to assure that their participation would be considered for summative assessment purposes, counting for a maximum of 10% of their final grades (2 values out of 20).

Before implementing the strategy, the main goals were discussed and clarified with the students, as well as the assessment criteria which have resulted in the following descriptive dimensions:

I). 'Quality criteria' (1,5 values out of 2), concerning two factors:

I.1. Cognitive level of students' reasoning

Questions can be classified according to the mental processes required to answer them. For example, the ASI categorization system of Pedrosa-de-Jesus, Teixeira-Dias, Almeida and Watts (2006) considers three levels of questions: A) Acquisition (low cognitive level), S) Specialization and I) Integration (high level questions) (see Table 2 for a more detailed description).

Since one of the aims was assessing the 'quality' of students' reasoning it was decided to code students' posts using the ASI system. However we have introduced a slight adaption: since the entire message is fundamental to contextualize and understand the thinking processes of each student, the assessment unit was the entire message and not only the questions *per se*. It was also decided to assess all the students' posts whether the question was explicit or not, because the inquiry disposition of the student might be embedded in the message without explicitly formulating a question.

I.2. Scientific accuracy

Students' posts were also classified according to their scientific accuracy considering three levels: B1) scientifically incorrect; B2) with some scientific incorrectness; B3) scientifically correct.

Finally, quantitative criteria were defined in order to better translate the 'quality' of a student post, into a discrete value. The combination of the cognitive level with the

scientific accuracy of each post resulted in four different ‘levels of quality’ of the posts: 0, I, II and III. The definition of these ordinal categories was based on concrete examples of students posts for all possible combination (for example A2B1), and took also into account the defined learning outcomes of the curricular unit, (see step 1 of Figure 3). For evaluation purposes, different ‘weights’ for each level of ‘post quality’ were defined (see step 2 of Figure 3).

II. Frequency criterion (0,5 values out of 2):

Besides ‘quality’, the number of students’ posts was also a criterion for assessment. To assure that participation would be considered for final assessment, each student had to post at least two questions/comments during the semester. Higher frequencies were positively considered: more than 5 posts – 0,5 values; 2 or 3 posts – 0,3 values; 2 posts (the minimum required) – 0 values.

The final mark was achieved by adding the value of qualitative assessment indicators (maximum of 1,5 values) to the value concerning the frequency of posts (maximum of 0,5 values).

In the following sections, particular aspects of the implementation of the strategy during 2007/2008 and 2008/2009 and some student’s outputs will be described and discussed. Transcripts from the interviews with the teacher and some students will also be presented to complement and sustain discussion.

(Insert Table 2 here)

(Insert Figure 3 here)

2.1. “Questions in Biology” – 1st edition (2007/2008)

The purposes of the ODF as well as the assessment criteria were explained and clarified by the Professor during the opening lecture of the semester. The “Questions in Biology” forum started with a message posted by the teacher (Figure 4), communicating explicitly a specific learning challenge, which represents a moment identified by Garrison and colleagues (2000) as a ‘triggering event’. According to these authors, ‘a critical role of the teacher is to initiate, shape and, in some cases, discard potentially distracting triggering events so that the focus remains on the attainment of intended educational outcomes’ (Garrison et al. 2001, p. 10).

(Insert Figure 4)

The ODF lasted nearly four months (the entire semester). Students questioned, discussed and argued about topics on Evolution having posted a total of 222 posts, which represents a mean of 3,17 posts per student (Figure 5). A larger number were written near the end of the semester, namely during the first two weeks of June 2008. Despite the fact the teacher has enhanced in each lesson the importance of a continuous participation in the forum, the majority of students behave strategically by posting the 2 required messages near the deadline in order to fulfil the assessment criteria. In spite of this, the global analysis of the quality of all posts during the semester revealed that 42% were at the highest level (Level III) and 13% were at Level II. Thirty per cent of the posts were assessed at Level I and 15% at Level 0. Since the majority of Level 0 and Level I posts were written during the final week of the ODF (76 % and 65% respectively), it might be assumed that ‘last’ minute posts tend to be at low quality, having the risk of jeopardizing deep learning. Some interviewed students confirmed this assumption:

‘When I realized that the deadline was so close I said to myself “I need to do something!”... but I saw so many things written in the forum that I realized I wouldn’t

have time to read it all, so I have decided to chose 2 or 3 topics and answer to them... I wrote a brief message based on those topics (...) If this wouldn't have been included in the assessment, maybe I wouldn't have made an effort.' (Filipe - fictional name)

'Even though I was not able to make a comment with the objective of getting a higher grade, at least I have participated not to take the risk of losing everything, right? (...) this last comment was only to participate'. (João - fictional name)

On contrary, Level III posts achieved the highest frequency during the middle of the semester, namely during May, with 47 posts (51% of the total number of Level III posts). These evidences reinforce that students need time to reflect, adapt and integrate knowledge, and that ODFs can promote high levels of thinking if proper conditions are created, such as giving students the opportunity to formulate several posts, and to improve the following ones, by constructive teacher feedback, and also by reading posts from their peers.

(Insert Figure 5)

The fact of ODF being a written-based communication seems to have also a positive influence on the quality of students' intervention. Evidences from oral discourse analysis, based on transcripts from the audio taped lectures, showed that a total of 60 students' question took place during the semester, corresponding to less than one question per student. A mean number that is, even though, higher than in many other first year university disciplines. The large number of students' oral questions formulated during 'TLB' lectures, was considered at low cognitive level, corresponding to 53%, and only 13% were at highest cognitive levels. These are not surprising results, since when it concerns oral discourse the number of students' questions tends to be too small and the cognitive level preferentially low (Maskill and Pedrosa de Jesus 1997). Indeed, according to Garrison and colleagues (2000) text-based

communication provides time for reflection, for organizing and structuring ideas, for encouraging discipline and rigor in thinking and communication, being very closely connected to the development of critical thinking.

Also, comparing students' behaviours during lectures and the ODF, it was clear that many of the students that generally attended the lecture silently took the chance of presenting their opinion or doubts, via the ODF. This is also an advantage of this alternative way to communicate, providing opportunities for students to interact with each other and the teacher, according to their preference of communication (written or orally):

'At least while we are studying we have this facility, otherwise we would have to contact the teacher (...). Also I think it is useful for those persons who are shy and for those who haven't the capacity and time for formulating questions during classes.' (Alexander – fictional name).

It is important to emphasize that the teacher, at any moment, didn't 'force' a specific topic. The most posted subjects were indeed raised by the students (not the teacher). For example: Creationism/Intelligent Design; Evolution theories Vs Religion; Human Evolution Vs Cultural Evolution; Evolution and Homosexuality and specific examples of Evolution – such as Platypus (*Ornithorhynchus anatinus*). The intention was to allow students to discuss topics of their 'genuine' interest. However, whenever appropriate, the teacher enhanced particular important ideas raised by the students, challenging or giving feedback to them in order to stimulate participation and sometimes refocusing discussion (see Figure 6) concerning the contents and learning outcomes of the discipline.

(Insert Figure 6 here)

Throughout the semester the teacher posted a total of 39 messages, which were deliberately reduced as we can see by the following statement from his interview:

'I realized very soon that, after I have written a post at the forum, the discussion between the students tended to drop. They tended to post messages with the perspective of delivering a message to me. But that is not the point. It is THEIR discussion.' (Teacher)

Indeed, the students initially clearly posted isolated messages addressed to the teacher, and the following posts tended to have no 'logic continuity' with the previously presented ideas. This means that the student can be actively engaged in the discussion, posting a lot of messages, but not interacting with his peers, he is constructing meaning individually instead. Students' engagement in monologues without connecting to other contributions is one of the challenges that the teacher faces while conducting discussion (Garrison and Cleveland-Innes 2005). In consequence, besides appealing several times for the importance of interaction between the students, the teacher started to structure his participation by integrating in one single post the ideas of several students, showing the 'expected' exercise of trying to connect others messages with own thoughts and not just 'dropping' an isolated idea.

The global evaluation of the "Questions in Biology" forum was very optimistic as it was considered successful in motivating students as well as supporting them in developing written questioning and argumentation. The teacher, at the end of the semester, also made a very positive balance focusing the potential of this kind of strategy in helping him to know better the students and their learning capabilities, which normally are only evidenced at the end of the semester during the typical written exam:

'This kind of strategy is very time consuming. But the final balance is very positive. It helps me to feel more confident about the students' final grade. I started to know better the students...almost each student...' (Teacher)

2.2. “Questions in Biology” – 2nd edition (2008/2009)

After the encouraging and stimulating results from the first edition, it was decided to continue using the strategy during the following academic year. Some improvements, based on acquired experience from the previous year were introduced, namely:

i) Construction of a written document with important guidelines for students about the “Questions in Biology” forum:

During the first year of implementation, students had frequently doubts, specifically about the assessment of their participation in the ODF. In order to better support students, and also to minimize the repetition of instructions, a document describing the main learning outcomes of the discipline, and how they were related to the “Questions in Biology” goals, was written.. Assessment criteria and specific guidelines on ‘how to maximize’ the quality of students’ intervention, using concrete examples of students previous posts, were also integrated. This document was posted on the e-learning platform, after being clarified and discussed with the students during the first lecture.

ii) Organization of the “Questions in Biology” forum into three smaller periods of time:

As a result of the students’ tendency to deviate from Evolution as the main thematic and to ‘post’ frequently isolated messages, without connecting to previous exposed arguments or repeating the same idea without adding new aspects of it, it was decided to try to ‘orient’ the discussion for specific themes, by splitting the ODF into three thematic blocks (focusing each discussion). Each thematic block was initiated by a teacher ‘triggering event’ related to the curricular contents being covered at that time during lectures (Table 7). In order to assure a continuous participation on the ODF, it was also decided that each student must post at least

two comments/questions in each of the three blocks, in order to assure the inclusion of their participation in the final assessment (maximum of 2 values).

iii) Introduction of a formative assessment period:

Considering students' initial difficulties and doubts in understanding the purposes of the strategy, it was decided that the first block (three weeks) would be only considered for formative assessment purposes, giving them the time for adaption to the new strategy. On the end of the first block, during a 'normal' lecture, the teacher, in collaboration with the researchers, has commented on students' difficulties and gave some stimulating suggestions and constructive feedback, supported on the exploration of some students' selected posts.

iv) Extending the "Questions in Biology" strategy by implementing presential group discussions:

Data collected by interviewing some students, on the end of the first year, revealed that several colleagues, particularly those that tended to participate and discuss frequently during normal lectures, felt somehow 'harmed' by the fact that only the written participation at the ODF was considered for assessment. Therefore it was decided to introduce two presential group discussions, aiming at giving students the opportunity to synthesize the main arguments/ideas that have been emerged during the lectures and the ODF discussion. Both were carried out during a 'normal lecture' having duration of two hours. The first discussion, with formative purposes, was organized in order to match the end of the first thematic block. The second discussion moment was at the end of the semester, after the third thematic block. It was then decided that only the second discussion moment would be considered for summative assessment purposes. Since it was the first time that this strategy was adopted, corresponding to an 'isolated' moment when compared with other tasks that students had to accomplish during the semester, the final discussion was proposed to count 0,5 values out of

20. All students agreed. Therefore, the students' participation at the "Questions in Biology" could count for 2,5 values out of 20 on their final grade, instead of the 2 values like the previous edition. The assessment criteria for the participation in the forum were maintained (1,5 values for quality and 0,5 values for frequency), since it was found useful by analysing and assessing the discourse content, according to the learning goals.

(Insert Table 7 here)

On what concerns the online discussion forum, a total of 248 student posts were written along the semester: 43 posts during the initial formative period, 126 during the first summative discussion and 79 posts during the second summative discussion (Figure 8). Strategic students' posts, at deadline eve, were again observed during the formative block. Therefore, the teacher used the formative period as an opportunity to give clear instruction to the students and to emphasize how their behaviour could have negative effects on the summative assessment of the posts: if this situation would repeat in the following blocks it would be very difficult to give feedback and to assess the posts at appropriate time. These teacher's advices and recommendations had indeed some effect on the following blocks, but not as much as it would be desirable.

From the total number of students attending the curricular unit (N= 70), fourteen didn't have any sort of participation in the online forum. Thirty nine participated during the entire summative period (both blocks) and 17 students have participated only on the first summative challenge, having no participation at all during the second block. This corresponds to a mean of 2,25 messages per student during the first summative block and a mean of 2 messages during the second one.

As a consequence of the decrease in the number of students' participation, the number of students' posts also dropped to around 40%, passing from 129 to 79 posts. Students' feedback from the interviews revealed that the nature of the thematic was the main cause, since they recognized that they did not even know what to post on.

'For example, on the last theme, I was not able to comment until the day before because I thought it was too complex, and there was too much things to read (...) I didn't know what to write, it was a theme difficult to comment.' (Jorge - fictional name)

'On the last block there were less topics being addressed and none of them raised interest to me... and to start a new topic, well, I didn't know where to start.' (Manuel - fictional name)

On the other hand, the teacher also perceived that eventually some students didn't understand that they should have contributed at least with two posts in each block. This situation was discussed afterwards in the classroom and it was decided to drop the criterion of 'obligation' to participate in each block. Therefore, for assessment purposes the first and the second summative blocks were considered as just one. Frequencies of more than two posts per student were, like in the previous year, positively considered.

On what concerns the quality of students' posts, the patterns used on previous academic year were globally maintained (Figure 8): posts at Level III were the most frequent (51%, 63% and 31% for the total number of posts of each block respectively). Once more, Level III posts achieved its highest expression during the middle of the semester. On contrary, lower level posts, namely Level 0 and Level I, were more frequent at the beginning and the end of the semester (Level 0: 16% for block 1, 12% for block 2 and 20% for block 3; Level I: 16% for block 1; 13% for block 2 and 25% for block 3).

(Insert Figure 8 here)

As referred previously, two presential group discussions were organized. During the summative group discussion, a mean of 21 students participated in each class. In 'normal' lectures, five to ten students commonly tried to interact with the teacher, who constantly appealed and stimulated students' involvement in the classroom discussion. Also, student-student interactions, which were very rare during lectures, have risen considerably during the group discussions addressed to the "Questions in Biology" forum. Other behaviours were also observed and were considered very positive, evidencing students' engagement, such as: i) taking notes from what was being said, particularly statements from other peers, ii) using them to support and structure their talk, and iii) bringing into the discussion some references, such as books marked on specific pages. For example: "Climbing Mount Improbable" and "The Blind Watchmaker: Why the Evidence of Evolution Reveals a Universe without Design" by Richard Dawkins, or "The Red Queen" by Matt Ridley.

Since it was decided, from the beginning, to consider for assessment students participation in the last summative discussion, a specific observation grid was designed, in order to check for evidences of students' competencies such as criticality and clarity of their interventions (Figure 9). During this summative discussion, the two Science Education researchers, acting as non-participant observers, filled in the observation grid for each student that has participated, in order to allow the teacher to be fully concentrated and engaged on the discussion. Afterwards, the researchers discussed and crossed their annotation, ranking the students in a scale from 0,1 points (level 1) to 0,5 points (level 3), according to the established criteria (Figure 9). This proposal was then discussed with the teacher.

Like in the previous year the final balance of the implementation of this strategy was considered to be very positive. Again it was possible to observe, during the semester, evidences of students' motivation and engagement in learning. The reflection about students' behaviour during the first year allowed 'tuning' the strategy, according to undergraduates' needs and characteristics. The teacher also considered "Questions in Biology" as better settled towards the desirable goals, and prized the entire *process* of designing and implementing the strategy aiming to create a learning environment that provides stimulus and encouragement for students' development, through small shifts in the adopted teaching practices. Indeed, like Teixeira-Dias et. al (2005) have stated:

' (...) activity of 'fine' tuning is not so much a result of a once-for-all modification, but a relatively constant concern and evolution that requires almost permanent consideration of students' questions and feedback, and of student–teacher and student–student interactions.'

(Teixeira-Dias, Pedrosa de Jesus, Neri de Souza and Watts, 2005, p. 1127).

(Insert Figure 9 here)

3. Main conclusions

The present context of Portuguese Higher Education, asks, in the light of the so-called 'Bologna Process', for curricular and pedagogical reforms in order to promote the acquisition and development of competencies such as critical questioning and argumentation. While curricular reforms asks for larger course tuning, pedagogical reforms might start at the classroom itself, with slight initial changes on teaching practices.

Within this chapter it was intended to describe the process of designing and implementing a strategy called "Questions in Biology" aimed at enhancing students' questioning about

Evolution topics, and, therefore, contribute for active and deep learning in this thematic. Although the strategy was implemented in the context of a discipline taught by one teacher, it was not a 'lonely' process. In fact, the design and also the implementation of the strategy resulted from a collaborative work between the teacher and a group of researchers in Science Education. Following a co-researcher model (Macaro and Mutton 2002), which allows each participant in the process to benefit from the enterprise, the Science Education researchers had the opportunity to do research in natural teaching-learning contexts, and the teacher had the opportunity to reflect on data collected from his own lectures, obtaining also some support in the design and implementation of innovative strategies: *'These kind of strategies are very important for the students, and exciting for the teacher. But, it is, honestly, impossible to do these things alone. There is no time and too much pressure.'* (Teacher)

The strategy "Questions in Biology" started to be an online discussion forum where the teacher initiated the discussion by communicating a specific learning challenge and students interacted mainly with each other, discussing specific ideas related to Evolution. During the second year, the strategy was again implemented, however with some adaptations, improvements and innovations according to the acquired experience and the students' outcomes from the first edition.

Focusing on the quality of students' learning, evidences for the positive impact of the described strategy were observed such as the increase of teacher-student and student-student interactions, both orally (group discussion) and written (ODF). Particularly the high frequencies of Level III posts at the discussion forum provide evidence that students are able to think at higher cognitive levels when proper conditions are given. Through the ODF students had the opportunity to share and construct collaborative knowledge, also training written argumentation. This allowed the teacher to know better the learning abilities of each student, even before the final exam. Finally, some evidences of promoting study methods

were also observed. In order to participate in (oral and written) discussions with their *own* ideas and their *own* knowledge several students started to seek information in books, or other references, besides the indicated course books.

It is believed that the success of the “Questions in Biology” is rooted on the conscious effort of aligning the adopted teaching methods with the real learning outcomes and particularly with the assessment modes, since evaluation influences student behaviour and adopted study methods: *“I think assessment has influenced us...We had to pose at least two questions but I ended up making more...The first question I asked I felt obligated to do so...But, then the other questions came out spontaneously because we became to interact, and then it became natural.”* (Anna – fictional name)

Formative assessment moments, such as continuous teacher feedback in order to stimulate and sometimes focus students’ reasoning, also revealed to be very important for the students’ learning.

It was realized that the discipline, through the implementation of “Questions in Biology” stood out due to the creation of a ‘complementary environment’ that allowed students’ to ‘reveal’ other interests and abilities, besides the ‘memorization of information’:

“I liked very much this discipline, because here we were assessed by other skills, besides writing well at the exam... I know that I am better talking. We discussed a lot in this discipline. In the other disciplines this didn’t happen...unfortunately” (Peter – fictional name)

Considering the exposed above, it is our opinion that one possible way of implementing successfully innovative pedagogical approaches is to focus and reflect on its own dynamic characteristics. It is not positive, or realistic, to perceive ‘pedagogical reforms’ as once-for-all-modifications that are perfect at its first trial. Collaborative work between university

teachers and researchers in Science Education might be one step forward to enhance quality in Higher Education promoting the scholarship of teaching and learning.

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Figures

Figure 1 - Main entrance to the ODF “Questions in Biology”

Figure 3 - Translation of the “quality” criteria of students’ posts into a quantitative mark for summative assessment purposes

Figure 4 – First triggering event of “Questions in Biology” (2007/2008)

Figure 5 – Frequency of students’ post and level of quality during first edition (2007/2008)

Figure 6 – Example of a student-teacher interaction episode at the ODF

Figure 8 – Frequency of students’ posts and level of quality during the second edition (2008/2009)

Figure 9 – Levels of students’ skills and competencies assessed during presential group discussion

Tables

Table 2 - The ASI questioning categorization System (Pedrosa de Jesus, Teixeira-Dias, Almeida and Watts 2006) with examples of questions from the “Questions in Biology” forum

Table 7 – Initial triggering events of each thematic block (2008/2009)